SOIL SURVEY OF THE LONG ISLAND AREA, NEW YORK.

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LOCATION AND BOUNDARIES OF THE AREA.

The area surveyed covers the western two-thirds of Long Island and comprises a land surface of 845 square miles. The soils are plotted on a base map made up of United States Geological Survey sheets as follows: Parts of the Patterson, Harlem, and Staten Island sheets and all of the land surface of the Brooklyn, Hempstead, Oyster Bay, Babylon, Northport, Fire Island, and Setauket sheets. The

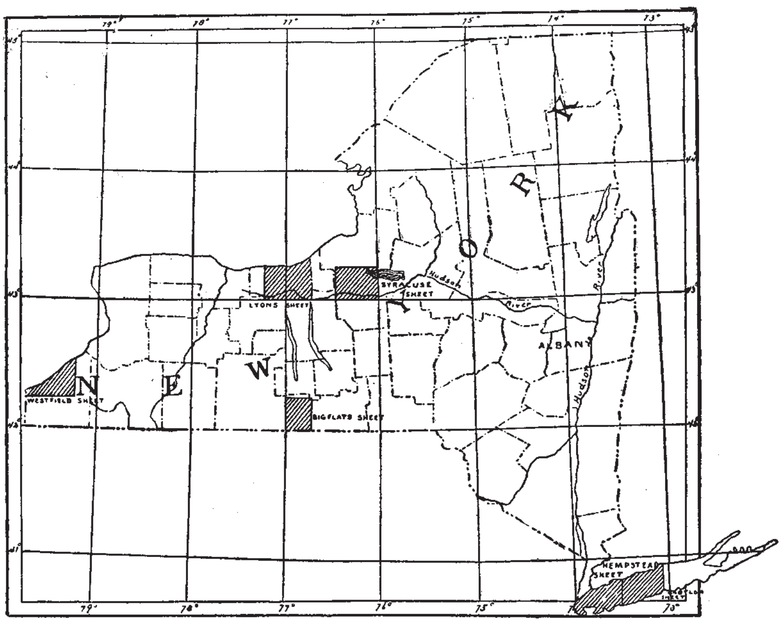

FIG. 3.—Sketch map showing location of the Long Island area, New York.

eastern boundary of the area passes north and south across the island, a little east of Patchogue on the south coast and of Port Jefferson on the north. The Atlantic Ocean, bordered by a series of narrow sand beaches, within which lie shallow bays and wide areas of marsh lands, forms the southern boundary of the area, while the East River and Long Island Sound form the northern boundary. The north shores

are more abrupt than the south, and there are comparatively few marsh areas, the cultivated fields extending often to steep cliffs which separate them from the water boundary.

Both the north and south shores of the island are very much cut by bays and minor estuaries.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The early history of Long Island, including its discovery by the Dutch, its settlement by both the Dutch and the English, the conflicting claims of the two races, and the final extinguishment of the Dutch claim, is well known. The Dutch occupation of Long Island began with a single farm in 1625. The Dutch population on the western end of the island had not increased sufficiently for the establishment of local governments until 1639. The first Dutch farms, or boweries, were located in Kings County, within the present limits of Brooklyn, New Utrecht, Flatbush, and Gravesend. In the meantime the English Government had granted Long Island to the Earl of Stirling, and his agent arranged for the colonization of the eastern end of the island. The settlers began to arrive in 1640. The English colonists did not merely secure individual grants of farm land, like the Dutch, but came over from Connecticut in organized bodies and occupied township grants. These townships, so far as government was concerned, were not only independent of England and Connecticut, but also practically of each other. Their form of government was partly clerical, but chiefly democratic. Gradually the English settled as far westward as the towns of Gravesend, Newtown, Flushing, Jamaica, and Hempstead. By the treaty of 1650, defining the limits between New England and New Amsterdam, the present territory of Suffolk County became definitely English and the remainder of the island was recognized as Dutch. Later Long Island suffered the same changes of ownership as the remainder of New Amsterdam. In 1683 the colony of New York was divided into counties, of which three—Kings, Queens, and Suffolk—constituted the entire area of Long Island. It was not until the incorporation of the Greater New York that the portion of Queens County outside the city limits was erected into Nassau County.

Under English colonial rule large tracts of the territory of Long Island were granted to individuals and to communities, although on the eastern end of the island much smaller tracts were secured from the agents of Lord Stirling and his successors and by the purchase of the same lands from the Indian occupants. The majority of the early settlements were made near tide water because of the accessibility of such positions. The interior portions of the necks along the northern shore were cleared and tilled or held in pasturage, while the steep sided margins were left in forest. The great Hempstead plain was

found in a prairie condition, and was at first utilized in common for pasturage and the cutting of hay, both by communities and by individuals. Parts of the wooded interior were cleared merely for the timber products, and many of these areas have been cleared again and again of succeeding growths of timber, although some of them have ultimately become agricultural land. Tide mills for the grinding of grain were early established at suitable points along the shore, and bounties were granted to millers for erecting grinding mills upon the smaller streams of the island. Many of the towns owned portions of the salt marshes, where salt hay was cut. Similarly, some of the warrants to the scout or constable empowered him to employ the services of the inhabitants for cutting brush or bushes from the common pasture land. In the early days grain crops, cattle, sheep, dairy products, firewood, and timber constituted the chief farm products of Long Island. The decline of this general farming on Long Island, with the change to market-garden and trucking conditions, is best shown by the rapid change in the amount of milk shipments from Long Island to New York City. In 1885 Long Island furnished 1,661,260 gallons of milk and cream to New York City; in 1890, 1,236,570 gallons; in 1895, 503,800 gallons; and in 1899, 3,890 gallons, since which time the supply has sunk to a point so small as not to be reported by the railroad authorities. At the present time the greater part of the island is held in severalty by private owners. The old commons have disappeared, and on the western third of the island nearly every level acre not occupied for building purposes, or held in large country estates, is under intensive cultivation to market gardening and trucking crops. In the eastern part of the island narrow strips along each shore are under cultivation, and a few scattered settlements occupy positions in the central portion. With these exceptions, and that of the northeastern portion of Suffolk County, which lies outside the limits of the present survey, the greater part of that county consists of a sandy waste occupied by scrub oak and pitch pine. So far as agriculture is concerned it is as strictly a desert country as many parts of the arid West. Loose sand is drifted from place to place with every wind. Extensive fires frequently sweep through the scrubby forest and only the most rugged vegetation can maintain itself. The soil itself is not inherently unproductive, for in places where the water table is only a few feet below the surface, and at the scattered points where a little irrigation is practiced, ordinary agricultural operations are successfully carried on even upon the most sandy land. In this way it is demonstrated that the 4 feet of ordinary rainfall reaching this portion of Long Island does not, on account of the sandy nature of the land, furnish sufficient moisture for the needs of growing crops. It is the chief cause of the unoccupied condition of nearly two-thirds of Suffolk County, and can only be remedied by irrigation. The demonstration of the possibilities

of irrigation within this area should constitute the next most important step in the agricultural history of the island.

The entire area of the island secures good transportation facilities from the Long Island Railroad, which was constructed from Brooklyn to Greenport in 1844, along the south shore to Montauk Point, and in many branches to north shore points since that day.

CLIMATE.

The following table, compiled from records of the Weather Bureau, shows the rainfall and temperature for three stations in different parts of the area surveyed:

Normal monthly and annual temperature and precipitation.

Month.	New York.		Willets Point.		Setauket.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.
January	30.5	4.04	30.3	4.24	30.7	4.18
February	31.5	3.80	30.2	4.33	30.4	4.22
March	36.9	3.99	36.3	4.11	36.0	4.51
April	48.1	3.38	47.9	3.64	47.3	3.34
May	59.5	3.18	57.2	4.15	58.0	3.96
June	69.0	3.13	70.0	2.89	67.0	2.43
July	73.6	4.26	74.1	5.54	72.0	4.87
August	72.2	4.70	73.0	2.72	71.1	4.54
September	65.9	3.72	66.1	3.85	65.0	3.45
October	55.0	3.51	55.0	3.54	54.2	4.48
November	43.4	3.80	42.8	4.53	44.3	4.48
December	34.4	3.29	33.4	3.12	35.5	4.65
Year	51.7	44.8	51.4	46.66	50.9	49.11

The small rainfall in June is a marked feature in all three stations, as is also the heavy precipitation in July.

Fragmentary records at Brentwood, in the central portion of the island, indicate a mean temperature somewhat below that of the coast line stations and a precipitation somewhat above that along shore.

The absence of records in Kings and Nassau counties prevents the formation of any general conclusions in regard to variations in climate from place to place on Long Island. It is generally stated, however, that the season is about one week earlier in spring on the plains bordering the south shore than in the more hilly country along the north shore.

The annual mean isotherms show that Long Island experiences a temperature considerably milder than that of the remainder of New York State, and it is noticeable that the extremes between winter and summer temperatures are less than on the mainland. This should be ascribed to the equalizing influence of its slight topographic relief and of the surrounding water.

The precipitation charts indicate that Long Island receives as great an annual precipitation as any portion of the State, with the exception of a small area in the Adirondacks. The snowfall data indicate the smallest fall of unmelted snow on Long Island of any region in New York.

It becomes evident at once that the nonproductive state of nearly one-third of Long Island is not due to abnormal climatic conditions. In fact, the climate of Long Island is better suited to agricultural pursuits than that of the remainder of the State. The average precipitation amounts to about 4 feet of water, an amount considered adequate for the production of crops under all ordinary conditions.

The tendency to drought in June is clearly shown by the Weather Bureau records.

The great controlling factor which renders so many acres of land in the central portion of Long Island unproductive is the extremely sandy nature of the most widespread soil types, and the additional fact that even the more retentive soils are extremely shallow, and are underlain to great depths by coarse, porous, unretentive beds of sand and gravel. Nothing but systematic irrigation can counteract these characteristics and render the land permanently and continuously productive. Without the aid of irrigation the more sandy soils of central Long Island can not become of any great agricultural value.

PHYSIOGRAPHY AND GEOLOGY.

Long Island resembles in form a great fish, with the head resting near the mainland of New Jersey and the body extending eastward from 5 to 25 miles south of the Connecticut shore, the tail extremities being formed by Orient Point on the north and Montauk Point on the south. There is a bold range of hills extending from Fort Hamilton past Rosslyn, Huntington, Port Jefferson, and Greenport, which, with the plateau areas lying along the north shore, forms the main body of the island. A second range separates from this one near Rosslyn and gradually diverges southward to its termination near Montauk Point. Included between the two ranges is a nearly level tract of country, forming a gently southward-sloping plain. It rises to an elevation of about 240 feet near Huntington and abuts with a sharp change of slope against the northern hill range. It descends from this boundary with a slope of about 10 feet per mile to the southern hills and coalesces through the gaps in this range with the more extensive plains which constitute all of the island south of the hill country. Thus the physiographic features of the island are simple.

There are no large streams on Long Island. The lakes are limited to a few large ponds and a multitude of small ones. On the other hand, the shore line is complex. The northwestern shore along the Sound is indented by deep tide-water harbors extended southward into the land

mass by gorgelike streamways, now occupied only by very feeble streams. East of Mount Sinai Harbor the sound shore is smooth or gently curving, with no large indentations.

On the western end of the island the older land forms remain; on the eastern the activity of the waves formed in the sound has eroded back the shore and destroyed former inequalities.

The south shore is entirely different. Here the land mass sinks gently to the water's edge and extends out to form a part of the submerged Atlantic shelf. The heavy storms of the coast move landward from the southeast, and the waves, moving shoreward as low swells, are formed into breakers and surf by the shallowing of the water. This occurs at a varying distance from the shore line, and a series of low barrier beaches has been built by combined wave and wind action. The Great South Bay and Hempstead and Jamaica bays all owe their origin to this phenomenon. The still-water areas between the beaches and the mainland serve as catchment basins for water-borne sediment, and the extensive areas of tide marsh along the south shore are the result. In a somewhat similar way bars have been formed across the mouths of several of the north-shore harbors, and small marsh areas have been formed at the landward apex of the triangle which constitutes roughly the form of these bays.

With the exception of a few small outcrops of crystalline rock, occurring in the northwestern part of Queens Borough, Long Island is made up of unconsolidated clay, loam, sand, gravel, and bowlders. The oldest of these unconsolidated materials are the various-colored plastic clays which occasionally reach the surface in the northern part of the island. The character of included organic remains marks the clays as belonging to the Cretaceous period. The clay deposits form the basal framework upon which later materials were laid down, they markedly influence the circulation of underground water, and they furnish material for the limited manufacture of clay products. Aside from their effects on the circulation of underground waters they do not influence the agriculture of the country.

Succeeding these clays are certain beds of gravel, sand, and loam, which may or may not be of age greater than Pleistocene. Limited areas of gravel north of Plainview furnish the most noticeable surface development of such materials. The remaining mass of the island consists of various sands, gravels, and loams, which have been deposited either through the direct agency of glacial ice or in modified form as stratified drift and outwash plains from the waters draining from or pounded by the ice sheets.

In common with all of northeastern North America, the northern part of the region now occupied by Long Island was invaded in recent geological time by a great continental glacier moving outward from certain centers of dispersion. This sheet of ice, many hundreds

and even thousands of feet in thickness, moved in a southerly direction across New England and New York, burying the highest mountains, eroding the land surface, carrying the derived material of all grades of coarseness both within and upon the ice, and finally depositing sand, gravel, loam, and large masses of rock throughout its entire course. Such deposits usually attain their greatest thickness along the front of the ice, where the load is dumped through marginal melting. As the ice front fluctuates backward and forward over large or small distances a series of such terminal-moraine deposits may be formed. The two ranges of hills found on Long Island are terminal moraines. Of these the southern is the older, and the northern, which overlaps the other west of Rosslyn, is the newer. The two belts of gently sloping plains constitute material derived from the melting ice carried beyond the glacier front by the water and deposited either as a shallow-water shore deposit or as an outwash plain formed above tide water. The plateau area consists largely of roughly stratified sands and gravel, either formed between the glacial advances or else left during the final retreat of the ice. Material of the former class is covered by the till let down upon its surface during the final retreat. The sands of the latter class form local delta plains, as at Port Washington.

The agricultural influence of the geologic events and of the resultant physiographic forms is marked. This is manifested most strikingly in the depth of soil in the various physical divisions and in the influence of the material on which the soil mass rests. Throughout the extent of both belts of plains the combined depth of soil and subsoil is less than 36 inches; usually it does not exceed 24. At such depths it is underlain by a definite band of closely packed gravel or cobbles, which separates it from the coarse, porous sands and gravel below. As a result, the total feeding range of crops is limited to a root development in a scant 30 inches of soil. Even those trees which normally develop taproots have been forced to a shallow feeding system, for in few cases have any forms of vegetation been able to penetrate the gravel. The shallowness of the soil mass affects the growth of crops in two main ways. It limits root development to horizontal spreading, and this results in crowding among closely planted crops of long growth, like grain and grass. It also introduces another element of the same character in limiting the storage reservoir for the maintenance of moisture. Both effects tend toward low crop yields. This is counteracted in some measure by heavy applications of manure. These observations apply especially to the Hempstead loam, Sassafras gravelly loam, and Sassafras sandy loam; to a less degree to Hempstead gravelly loam and Norfolk coarse sandy loam, since the gravel band constitutes part of the soil mass in both of these types, and not at all to Norfolk sand and Norfolk coarse sand,

as these types are chiefly outcrops of the basal sands without the surface gravel and loam covering.

Contrasted with the plains soils, as enumerated, are the soils of the moraine region, the Miami stony loam and the Alton stony loam. They are hilly or rolling in topography. They are also developed to a much greater thickness. The marked difference, aside from texture, is the entire absence of a continuous gravel bed underlying the soil mass. On the other hand, there is a marked gradation downward in many instances, and only local areas of sharp demarcation. As a result the soil mass is thicker, varying from a minimum of about 3 feet to a maximum of 40 feet or more, with an ample opportunity for root development and a largely increased moisture reservoir. The coarse texture of the Plainwell stony loam excludes it from this generalization, as its texture, not its depth, is the paramount factor in its moisture capacity. Some areas of Miami stony loam and Alton stony loam have suffered from soil washing to such an extent that they also form an exception to the rule. In the plateau region, even where the soils are underlain by sand, the separating band of gravel is lacking, and the conditions for crop production are favorable.

The effect of these differing conditions is most marked in the case of forest growth and in the case of grains and grass among the cultivated crops. For shallow-rooted crops such as are raised on the market-garden farms, the loams and sandy loams of the plains are sufficiently deep and retentive of moisture. So also for small fruits. For this class of crops the advantage derived by thorough natural underdrainage is great. The soil becomes warmed to a temperature adequate for the germination of seeds from ten days to two weeks ahead of that of the hill country. Moreover, the checking of the supply of moisture in midsummer aids in forcing the crops to an early maturity. As a result the plains soils are well adapted to the intense cultivation of market gardening, while the hill and plateau regions are suited to orcharding and the production of grain and grass crops with a variation in rotation afforded by the cultivation of late truck crops, like potatoes, tomatoes, corn, and cabbage.

The physiographic features of Long Island affect its climatic conditions to some extent, as is shown by the meteorological data given under the heading "Climate."

SOILS.

Fifteen different types of soil are found within the present area. These are largely the gravelly, stony, and sandy loams. The relative extent of each type is shown in the table following.

Areas of different soils.

Soil	Acres.	Per cent.	Soil.	Acres.	Per cent.
Alton stony loam	100,608	18.6	Galveston sandy loam	16,448	3.0
Sassafras gravelly loam	94,848	17.5	Galveston sand	12,224	2.3
Norfolk sand	77,120	14.2	Plainwell stony loam	5,376	1.0
Norfolk coarse sandy loam	64,896	12.0	Sassafras sandy loam	5,248	1.0
Miami stony loam	52,032	9.6	Norfolk gravel	3,328	.6
Galveston clay	36,352	6.7	Norfolk coarse sand	1,856	.3
Hempstead loam	34,560	6.4	Total	540,928	
Hempstead gravelly loam	19,264	3.6			
Meadow	16,768	3.1			

HEMPSTEAD LOAM.

The surface soil of the Hempstead loam, to a depth of 8 inches, consists of a friable brown or black loam containing a small amount of white quartz gravel and locally becoming somewhat sandy. From 8 to 24 inches the subsoil consists of a heavy yellow to reddish-yellow silt loam, slightly gravelly. It is very uniformly underlain at a depth of about 24 inches by a bed of rounded quartz gravel embedded in a sandy loam matrix, all considerably stained by a coating of hydrated iron salts.

The Hempstead loam constitutes the chief soil type of the Hempstead plain. A slightly heavier phase of this type also occurs in southern Kings County, while small isolated areas are found farther east in the plain between the double range of hills.

This type is very level, its surface being interrupted only by narrow, dry stream channels along whose banks the underlying gravel outcrops.

The Hempstead loam is well drained by the underlying beds of sand and gravel. On the other hand, the texture of both soil and subsoil is sufficiently fine grained to maintain a fair moisture supply at all times. Its chief deficiency is the lack of depth. The soil body is definitely bounded by the underlying gravel band, which not only prevents any extensive downward development of the root systems of plants and trees, but also furnishes a leachy, dry base into which a large part of the moisture from each rainfall readily sinks.

The Hempstead loam, as found in Hempstead plain, is notable in being a natural prairie east of the Allegheny Mountains. In its natural state it bears a rank growth of sedge grass. It was treeless when first discovered and was originally utilized as commons for the pasturage of cattle and horses belonging to individuals and to communities. Later patents were taken out for portions of the plain, the areas were inclosed, and grass was cut for winter feeding. Ultimately cultivation was begun, and at present many of the finest farms on Long Island are located on this type.

The Hempstead loam produces good yields of corn, potatoes, tomatoes, cabbage, grass, and rye, the latter usually cut green and fed

as hay. The late truck crops do well on this type, but it does not bring the lighter crops to an early enough maturity to compete with the more sandy types. For the crops named the Hempstead loam is only second in value to the Miami stony loam.

The following analyses show the character of the fine earth of the Hempstead loam:

Mechanical analyses of Hempstead loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8959	½ mile N. of New Utrecht.	Brown loam, 0 to 12 inches.	3.15	2.64	7.36	4.36	4.86	15.68	46.22	18.80
8961	1 mile W. of East Williston.	Brown loam, 0 to 14 inches.	1.80	2.32	6.00	4.30	7.04	10.74	47.60	21.96
8957	2 miles NE. of Hicksville.	Brown loam, 0 to 10 inches.	8.26	2.70	8.06	3.96	4.88	8.96	49.20	22.20
8962	Subsoil of 8961	Yellow silty loam, 14 to 30 inches.	1.42	1.80	6.40	3.90	6.70	13.76	48.70	18.40
8960	Subsoil of 8959	Brown loam, 12 to 36 inches.	1.14	3.40	10.94	4.74	4.26	12.96	42.20	21.30
8958	Subsoil of 8957	Yellow silty loam, 10 to 30 inches.	.62	1.30	5.30	3.70	4.80	15.24	42.20	27.50

HEMPSTEAD GRAVELLY LOAM.

The surface soil of the Hempstead gravelly loam is a brown sandy and gravelly loam having a depth of about 8 inches. This is underlain by a yellow gravelly loam usually more silty than the surface soil. It extends to a depth of about 2 feet and rests on gravel and sand. The gravel in both soil and subsoil consists of small quartz pebbles from the size of a pea to 1 or 2 inches in diameter.

This type occurs around the margins of the Hempstead loam and constitutes a region where the coarser materials of the western plain were deposited by glacial outwash. The narrow dry stream beds of the plain have been mapped with this type.

The surface of the Hempstead gravelly loam is nearly level, sloping gently seaward. The type is well drained through the presence of thick underlying beds of gravel and sand.

In its more level areas the Hempstead gravelly loam is cultivated to market-garden crops. Corn, peas, beans, potatoes, cabbage, cauliflower, asparagus, and celery are raised to good advantage. The crops mature a little earlier than on the more loamy types but do not produce quite as large yields. The Hempstead gravelly loam is somewhat more productive than the Sassafras gravelly loam, but the heavy application of stable manure throughout the area masks the inherent fertility of the soil. It is possible to produce good crops on either soil.

The following mechanical analyses show the texture of the fine earth of this type.

Mechanical analyses of Hempstead gravelly loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8965	¾ mile SE. of Locust Grove.	Fine brown loam, 0 to 5 inches.	3.80	1.74	5.54	3.38	3.46	11.28	54.70	19.40
8963	½ mile NE. of Queens	Brown silty loam, 0 to 10 inches.	4.70	3.50	10.16	6.24	5.44	9.36	41.70	23.10
8966	Subsoil of 8965	Fine yellow loam, 5 to 14 inches.	1.54	2.80	7.18	3.24	2.98	12.30	56.00	15.40
8964	Subsoil of 8963	Yellow gravelly loam, 10 to 24 inches.	.50	4.80	10.10	7.00	6.00	11.40	42.30	17.80

GALVESTON SANDY LOAM.

The Galveston sandy loam consists of a surface mass of sandy loam and eelgrass turf, having a depth of about 1 foot. This is underlain by a gravelly sandy loam subsoil to an indefinite depth.

The Galveston sandy loam is found along the south shore of Long Island as a tide-water extension of the sandy upland soils. It also occurs along the lee side of the great barrier beaches. In this position it largely owes its origin to the mingling of wind-blown sand with the finer materials of the tidal flats. In a few localities small dikes have been built across narrow strips of Galveston sandy loam, and the type is then cultivated to rhubarb, onions, and radishes. In preparing the land, beds of the soil are thrown up, some 30 feet in width and of the desired length. Frequently open ditches are cut to carry off surplus rainfall. Fair crop yields are secured. No general attempt has been made to bring the Galveston sandy loam under cultivation.

The following analysis of a typical sample of this soil shows its texture:

Mechanical analysis of Galveston sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8956	Hook Creek	Gray sandy loam, 0 to 28 inches.	1.44	1.30	10.40	11.20	16.20	13.20	29.22	17.90

GALVESTON CLAY.

The surface soil of the Galveston clay consists of a black mud and of a matted mass of eelgrass roots. It rests at a depth of about 2 feet on a bluish or lead-colored silty clay. This is in turn underlain at varying depths by medium sand and gravel beds.

The type is chiefly developed in the Long Island area around Jamaica and Hempstead bays on the south shore and at the bases of the deep harbor indentations along the western end of the north shore.

The surface of the Galveston clay is very level and lies only a few inches above the limit of high tide. It is interrupted by winding, steep-sided tide-water courses kept open by tidal currents. Small pools of salt water are also scattered over the surface of the various areas. The Galveston clay is constantly saturated with tide water and no large portion of it has been drained. A few small areas of 30 to 70 acres along the north shore have been reclaimed for sanitary purposes rather than for their agricultural value. No crops are cultivated on the Galveston clay, but locally the salt grass is cut for hay, which has a value of $5 to $10 per ton, depending on the supply of upland hay.

By diking and draining suitably located areas of Galveston clay it could be made to produce good crops of beets, cabbages, onions, lettuce, and celery. The salt would need to be washed from the surface soil either by flooding or more slowly by ordinary precipitation before any crops could be produced. Beets should then be the first crop planted, and as the soil became less salty the other crops should follow in regular rotation. The reclamation of this type is discussed in a special chapter on drainage.

The following analyses show the character of this type:

Mechanical analyses of Galveston clay.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8955	Littleneck marsh ..	Silt clay, 0 to 36 inches.	7.51	2.00	6.58	3.98	19.38	11.96	36.70	19.26
8954	2 miles NE. of Far Rockaway.	Silty clay, 0 to 36 inches.	7.86	1.10	5.70	2.50	6.80	7.54	46.60	29.70

PLAINWELL STONY LOAM.

The Plainwell stony loam is characterized by a surface soil of medium to coarse gray or brown sand mixed with some fine gravel and con-

taining scattered bowlders. It is underlain at about 6 inches by medium yellow gravelly sand, which at 18 inches passes into a bed of coarse sand, gravel, and stone. Some portion of the surface material is usually of wind-blown origin, while the basal part is glacial. The bowlders are not so numerous nor so large as in the Miami and the Alton stony loams.

The Plainwell stony loam is chiefly developed along the southern moraine from Hauppauge eastward, though one area, formed by wind-blown sand resting on glacial material, occurs just west of Setauket. Its surface is hilly and consists of ridges and hollows. Even the deepest of these contain no standing water, as the soil is too porous.

The Plainwell stony loam is a leachy, sandy type not suited to agricultural operations. It is almost wholly occupied by oak, chestnut, and pitch-pine forest, and several fields once cultivated have been allowed to grow up to scrub oak. This type would produce peaches to fair advantage, and truck crops could be grown in seasons of average rainfall. Melons and sweet potatoes would constitute the best crops.

The following analysis shows the texture of the fine earth of this soil:

Mechanical analysis of Plainwell stony loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8990	1⅛ miles SW. of Coram.	Yellow medium sand, 0 to 36 inches	0.73	8.50	30.50	23.90	21.30	6.50	6.90	2.40

GALVESTON SAND.

The Galveston sand constitutes the sandy and gravelly beaches of both the sound and ocean shores of Long Island. The material composing the beaches is a medium to coarse quartz sand containing varying proportions of fine gravel and broken fragments of marine shells. Along the ocean shore, on Fire Island and elsewhere, a large part of this material, once thrown above the line of constant wave action, is blown into rounded dunes covered with wiry grass, cedars, and oaks. Along the north shore occasional small dunes have also been formed at the crest of the cliffs.

This material has no value as an agricultural soil in this latitude. In places where the movement of the dunes threatens cultivated fields the dunes should be planted to binding grasses and to drought-resistant trees, like black-jack and scrub oak.

NORFOLK COARSE SAND.

The Norfolk coarse sand to a depth of 36 inches or more consists of a coarse gray or yellow sand containing a small percentage of fine gravel.

Only 3 areas of this type, approximating 2½ square miles of territory, occur in the area. They are found in the pine and scrub-oak country just north of Babylon, Bayshore, and Islip.

The surface of the Norfolk coarse sand is level and forested. The type constitutes the outcrop of coarse phases of the thick beds of sand underlying the Long Island plains. This sand was deposited as outwash from the glaciers and consists of quartz sand, mica, ferruginous conglomerate, and small pebbles of quartz and other crystalline rock.

The Norfolk coarse sand is a typical "pine barrens" soil, and without irrigation it is too much subject to drought to be of any value for cultivation. With irrigation it would constitute a valuable truck soil.

The following table shows the texture of the soil of this type:

Mechanical analysis of Norfolk coarse sand.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
9003	1½ miles NW. of Barphore.	Gravel and coarse sand, 0 to 36 inches	1.31	10.18	31.80	21.80	13.20	4.52	11.10	7.20

NORFOLK GRAVEL.

The Norfolk gravel consists of rounded quartz gravel from one-half inch to 5 or 6 inches in diameter, mixed with a small amount of iron-stained quartz sand. The mass may be many feet or only a few inches in thickness. It usually rests upon coarse sand, but locally covers the sticky Cretaceous clays found near Wyandance and Bethpage.

The surface is rolling to hilly, and the only large areas of the type constitute the frontal slope of the hills near Plainview and Bethpage.

This gravel soil arises from the outcrop of old gravel beds partly overriden by the first glaciation of the island. These gravels, as elsewhere along the Atlantic coast, may be referred to the earliest Pleistocene deposition or to Pliocene shore-line beds. In the absence of any remains of organic life their age can not be definitely placed.

Agriculturally the Norfolk gravel is almost useless and should be allowed to grow up to forest.

SASSAFRAS SANDY LOAM.

The surface soil of the Sassafras sandy loam consists of 12 inches of fine brown or yellow sandy loam, occasionally containing a small amount of small gravel. It is underlain to a depth of 30 or 40 inches by a fine reddish-yellow sandy loam containing considerable finely divided mica and varying amounts of small gravel. The entire soil mass rests upon a thin bed of iron-stained gravel and coarse orange or yellow sand. This soil occurs between Canarsie and Sheepshead Bay at an elevation of from 5 to 30 feet above sea level. Its surface is almost flat, sloping gently toward the coast. It is interrupted only by a few narrow, shallow, trenchlike water courses, along whose sides the underlying gravel occasionally outcrops and the bottom of which contains water during only a portion of the year. Owing to its position and the character of the underlying materials, this soil is well drained, although the normal water table exists at a depth of only a few feet, as is shown by the level of water in wells and by the moisture which collects in the seaward portion of the small stream channels already mentioned.

This soil is a marine sediment deposited in water of moderate rapidity of motion, and it owes its uniformity of texture to a thorough sorting of materials at the time of deposition.

Owing to its proximity to Brooklyn, this type is almost exclusively devoted to market gardening and trucking. Early potatoes, peas, rhubarb, lettuce, onions, and similar crops chiefly are grown. Like all the market-garden soils near the city, the Sassafras sandy loam is heavily fertilized each year with stable manure and commercial fertilizer. It is cultivated on a very intensive system, by which several successive crops are produced annually. It is not so well adapted to trucking crops as the Norfolk sand or the more sandy phases of the Alton stony loam. It is capable of producing larger yields than either of those types.

The texture of the fine earth of this soil is shown by the following table of mechanical analyses of typical samples:

Mechanical analyses of Sassafras sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
9001	1 mile S. of Greenfield.	Fine sandy loam, 0 to 12 inches.	2.44	3.80	10.98	7.88	7.56	15.18	37.42	17.40
9002	Subsoil of 9001.....	Brown sandy loam, 12 to 36 inches.	.66	4.80	12.30	7.10	6.30	13.40	37.20	19.10

ALTON STONY LOAM.

The Alton stony loam consists of a medium to fine brown or reddish-yellow sandy loam, having a depth of 6 inches to 1 foot. The subsoil is a somewhat finer sandy loam, usually of a reddish tinge from the stain of hydrated iron salts. It extends to a depth of 30 inches or more and is underlain by gray or yellow cross-bedded sand and gravel. Both soil and subsoil contain numerous glacial bowlders of trap, granite, gneiss, quartzite, shale, conglomerate, and sandstone rock. This soil is also constantly gravelly. The gravel is well rounded to subangular white quartz or crystalline pebbles and often reaches 30 per cent of the total soil mass. It is most abundant on slopes and in the rounded hills of the two moraine belts.

The Alton stony loam occurs as lenticular hills north of Jamaica and in the vicinity of Newtown and Flushing, but is most extensively developed in the southern moraine, in the northern moraine east of Success Lake, and in the more rolling portions of the north shore plateau. It is the prevalent moraine and plateau type east of Hempstead Harbor.

This soil is usually rolling to hilly, rising to the highest points of the moraines and forming the highest elevation on Long Island, about 3 miles south of Huntington. The hills are separated by kettle holes and irregular valleys and the rolling plateau is cut by deep gorge-like valleys along the north shore. In these valleys the Alton stony loam descends to sea level. Along their sides the sand and gravel underlying the main mass of the type outcrop, forming a more sandy phase of the type. As the slopes are too steep for cultivation they are not mapped as a separate type of soil.

The sandy nature of this soil type, its elevation above sea level, and the almost constant presence of underlying sand and gravel beds gives it good natural underdrainage. The kettle holes in the moraine areas form the chief exception to this. There the finer sediment from adjoining slopes has accumulated to obstruct the downward seepage of the soil moisture. Frequently, too, local beds of clay or of heavier loam give rise to small springy or marshy areas. These are chiefly located at a change of slope where the downward percolation of soil water is interrupted and the moisture is conducted to the surface.

The Alton stony loam constitutes a gravelly or sandy phase of glacial deposition originating largely from the overriding at both glacial advances of previously existing beds of sand and gravel. These were reworked with additional material brought in from mainland sources and redeposited as moraine, till plain, and beds of stratified drift. The chief influence of the older sedimentary beds has been to furnish an unusually large amount of quartz to this glacial material, the particles varying in size from fine sand to coarse gravel and cobblestones several

inches in diameter. Some Cretaceous clay was also worked into the mass, forming small local bodies of plastic clay or clay loam. The majority of these influence underdrainage rather than the surface soil, but a few areas of them, too small to be mapped, occur in various parts of this type.

A large portion of the Alton stony loam is forested. The steep valley slopes bear a predominant growth of chestnut, with a characteristic undergrowth of mountain laurel, while the moraine bears scarlet and red oak, some white oak, hickory, chestnut, and in a few localities scattered pitch pines. Dogwood forms a notable undergrowth, with masses of ferns and considerable greenbrier among minor plants. Unoccupied fields grow up to cedar. The locust thrives on this soil and is cared for to form a supply of fencing material.

In the more western area of this soil the market-garden crops enumerated under Miami stony loam are produced. In Nassau and Suffolk counties the plateau areas are cultivated to early potatoes, sugar corn, asparagus, some cauliflower, tomatoes, cabbage, cane fruits, and strawberries. The cucumber is cultivated for pickling, and yields well on the Alton stony loam. It is chiefly raised from Jericho eastward, and is not confined to any single soil type. The Alton stony loam is too sandy to form a typical apple soil. The trees thrive and produce fine fruit, however, especially where the orchards are located around a water hole or other hollow where abundant moisture is found near the surface. Several fine orchards of Kieffer pears are located on the Alton stony loam, those near Huntington being especially productive and profitable. The Kieffer pear should be more extensively planted on this type. Grapes also do well, and the moraine belts, particularly the southern one, which is less subject to heavy fogs than other portions of the island, constitute a good soil and good location for vineyards. Peaches, cherries, plums, quinces, and cane fruits are adapted to the Alton stony loam, and the chief obstruction to their profitable cultivation lies in the presence of the San José scale and yellows in existing orchards.

The Alton stony loam forms a soil well adapted to the later truck crops. It will insure earlier maturity than the Miami stony loam, but not so large a yield unless heavily manured. Being somewhat sandy, the use of stable manure and the plowing under of green crops to furnish organic matter and nitrogen is a better practice than the use of large amounts of commercial fertilizers.

The following table shows the texture of the fine earth of the Alton stony loam:

Mechanical analyses of Alton stony loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8946	1½ miles NW. of Brookville.	Brown sandy loam, 0 to 5 inches.	4.78	4.40	17.70	14.00	13.50	10.60	26.90	12.20
8942	2 miles SW. of Port Jefferson.	Brown sandy loam, 0 to 9 inches.	1.25	3.70	18.00	9.90	7.60	13.80	34.40	12.70
8944	2 miles SE. of Port Washington.	Brown sandy loam, 0 to 12 inches.	3.13	5.70	16.82	10.32	15.12	12.84	25.20	13.40
8943	Subsoil of 8942....	Red sandy loam, 9 to 30 inches.	.74	4.70	15.50	10.10	7.00	13.50	38.20	10.94
8945	Subsoil of 8944....	Red loamy sand, 12 to 36 inches.	1.54	5.40	15.36	11.18	15.58	13.38	27.48	11.58
8947	Subsoil of 8946....	Fine yellow sandy loam, 5 to 36 inches.	1.66	4.20	15.22	15.22	14.02	13.44	25.32	12.50

MIAMI STONY LOAM.

This soil type consists of a very friable brown loam, having a depth of 8 to 14 inches. The surface soil is underlain by a silty or fine sandy yellow loam subsoil to a depth of about 30 inches, where a fine or medium micaceous yellow sand, containing a varying amount of gravel, is encountered. The surface of the Miami stony loam is strewn with large-sized, erratic glacial bowlders, chiefly diabase (trap), on the western end of Long Island, with gneiss, granite, quartzite, shale, and conglomerate farther eastward. Over the cultivated fields the majority of these bowlders have been removed and built into massive stone fences or used for road surfacing and constructional purposes.

The Miami stony loam is found in the northern moraine belt and upon the plateau north of it. Immediately northward of Jericho a single area of about 1,000 acres in extent lies in a hollow south of the moraine. Its presence is explained by the local overriding of the moraine by the temporary advance of the ice sheet.

The Miami stony loam in the moraine belt presents a rounded, knobby surface with the elevations interspersed by shallow, irregular hollows having no outlets and, therefore, frequently containing water during a large part of the year. On the plateau the surface is more level, but is still somewhat rolling and hilly. In the moraine the soil body frequently attains a depth of 10 or 20 feet, while on the plateau it is rarely more than 5 or 6 feet deep. In both cases it is underlain by coarse, cross-bedded sand and gravel, usually considerably iron stained.

The sand and gravel beds frequently outcrop on the steeper slopes, where an increased amount of gravel is also found. The slopes are subject to considerable soil wash, which leaves behind the coarser material and accumulates the finer particles in the hollows and at the line of junction with the plateau and plain. The Miami stony loam is a firm, compact, even-textured soil, which maintains a good supply of moisture during the entire growing season and furnishes a large space for the development of the root systems of the growing plant.

The Miami stony loam is a typical glacial soil. Its mineral components are finely divided fragments of rock mixed with larger masses of the same material. It has no definite structure, but consists of a mass of fine earth in which the gravel and bowlders are irregularly distributed. All of the material is in an incipient stage of chemical disorganization, leaving the component minerals in a form readily attacked by circulating water and its impurities. On the other hand, the minerals are not so thoroughly weathered as to reduce them to nearly insoluble compounds. The mineral fragments have undergone considerable mechanical disintegration, but not excessive chemical decomposition. The easily recognized minerals—feldspar, muscovite and biotite mica, hornblende, and quartz—are capable of furnishing slowly considerable amounts of potash, lime, iron, and silica to enrich the soil solutions feeding crops.

The material forming this soil type consists of morainal accumulations of glacially borne material and of the till deposited from the surface of the melting ice during its final retreat. In both cases the material has been modified since its deposition by the admixture of organic matter from decaying vegetation and by the redistribution of small portions of the mineral matter through soil washing.

The texture and structure of the Miami stony loam place it in the group of grass and grain producing soils usually classed as general farming types. Its location near a large city has caused it to be appropriated to a more intensive system of agriculture, and the farms on this type in Queens and Nassau counties are chiefly small-sized market gardens. Eastward, in Suffolk County, it is still farmed to grass and grain with herds of dairy cows and a few sheep. It produces good apples and some pears in all localities.

The ordinary market-garden rotation on the Miami stony loam produces three or even more crops from the same field each year. In the early spring kale, spinach, and rhubarb are marketed; then lettuce, radishes, and early peas follow; later cabbage, parsnips, carrots, beets, turnips, and onions are harvested; while some areas are devoted to sugar corn, potatoes, squashes, and cucumbers. The aim is to keep some crop constantly growing, and frequently rye is sown late in the fall and grazed both fall and spring and then turned under to add organic matter to the soil.

Some of the fruit and flower farms on this type employ irrigation in a small way, either by garden hose attached to city hydrants, or from windmill tanks, or by whirling spray machines, such as are used to sprinkle lawns. The method is expensive, but is justified by the results.

As on all other soils on the island, large amounts of stable manure and commercial fertilizer, usually special brands, are used. From 5 to 10 tons of manure and 1,000 to 2,500 pounds of commercial fertilizer are used per acre annually. Both classes of fertilizer are used to advantage—the manure to furnish organic matter, the commercial fertilizer to give a quick start to plant growth and to influence quality in the product.

The value of the Miami stony loam varies with the location. Within the boroughs of New York City it sells by the front foot, such lots being utilized to produce flowers and vegetables chiefly under glass or else in the field, pending their occupation as building sites. In the suburbs to the Nassau County line the type is highly valued for villa sites on account of its rolling topography and elevated position and because it usually overlooks the Sound at no great distance. Small plots sell at \$2,000 to \$6,000 per acre. Little of the type can be bought west of Nassau County at a lower figure. In Nassau County and western Suffolk the value decreases rapidly with distance from the city until a value of \$100 to \$500 per acre is reached.

Under the intensive system of market gardening little can be said of the adaptability of this soil to crops. The majority of the crops are produced by the fertilizer rather than by inherent fertility of the soil, and even its texture and structure are modified by tillage and the addition of outside material to suit the needs of the grower at any particular time. In general this type will produce good yields of the later truck crops, but will not bring them to as early maturity as the more sandy soils. It is the most drought-resistant soil on Long Island.

The following mechanical analyses show the texture of the fine earth of this type:

Mechanical analyses of Miami stony loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8973	¾ mile N. of Larkfield.	Heavy brown loam, 0 to 12 inches.	2.67	3.00	10.70	6.90	5.50	13.10	46.80	14.10
8969	1½ miles E. of Port Washington.	Brown loam, 0 to 8 inches.	4.65	2.10	7.26	5.46	7.38	16.48	44.82	16.50
8971	2 miles E. of Flushing.	Brown loam, 0 to 14 inches.	3.06	1.72	4.96	3.86	8.28	20.48	43.36	17.40
8972	Subsoil of 8971......	Yellow stony loam, 14 to 36 inches.	1.16	1.78	5.50	4.14	8.58	22.90	44.40	12.70
8970	Subsoil of 8969......	Yellow loam, 8 to 30 inches.	.69	3.50	7.26	5.38	8.28	17.38	43.40	14.60
8974	Subsoil of 8973......	Yellow silty loam, 12 to 36 inches.	.86	3.10	8.08	5.08	2.98	14.96	48.20	17.24

NORFOLK COARSE SANDY LOAM.

The surface soil of the Norfolk coarse sandy loam to a depth of 8 inches consists of a medium to fine sandy loam of a reddish-yellow color, which contains a large amount of fine gravel from one-fourth inch to 2 inches in diameter. The soil is always prevailingly sandy, but in the localities where the sand is medium in texture it packs to form a somewhat loamy surface. The subsoil is a granular sandy loam, containing a considerable amount of gravel. This reaches its greatest proportion at a depth of 16 to 24 inches. Below this depth the underlying material is a medium to coarse orange sand only slightly gravelly. In addition to its textural peculiarities, the Norfolk coarse sandy loam, where undisturbed, has a definite structure. The coarser sand particles and the fine gravel are well rounded, and the finer silt and clay particles adhere to their surfaces when the soil is ordinarily dry; when thoroughly wet the finer particles are at greater liberty to move, and consequently make the mass more loamy. This aids in the conservation of moisture and is a valuable property of the soil.

The Norfolk coarse sandy loam covers large areas in Suffolk County south of the later moraine. It is most extensively developed between Farmingdale and Ronkonkoma, from north of the main line of the Long Island Railroad to an irregular line following the Montauk division. Between the moraines it is most prevalent from Smithtown Branch eastward to Port Jefferson. In this region it is more extensively cultivated than elsewhere on the island.

The surface of the Norfolk coarse sandy loam is quite flat, only being interrupted by shallow stream channels, the majority of which are constantly dry. The surface slopes gently seaward and forms the most level portion of the island.

The Norfolk coarse sandy loam constitutes the portion of the outwash plain intermediate between the Norfolk sand and the Norfolk coarse sand on the one hand and the Hempstead gravelly loam and the Sassafras gravelly loam on the other. It represents the outcrop of the more loamy sands which underlie all of the Long Island plains. It differs from the Hempstead gravelly loam chiefly in containing much less organic matter, and from the Sassafras gravelly loam in being uniformly more sandy.

Probably 85 per cent of the Norfolk coarse sandy loam is grown up to pitch pine and scrub oak, with scattered scarlet and white oak clumps. Forest fires overrun a large proportion of these plains annually with little interference, as large areas of the scrub-oak country are held by nonresident individuals and corporations. Only the scrub oak and pitch pine can survive under these conditions, and they have become the predominant forms of vegetation. That other forms of trees can thrive on this soil is shown by the presence of many yellow pines in places where they have been planted and protected.

Agriculturally the Norfolk coarse sandy loam is used chiefly to produce local supplies of berries and fruit and for the cultivation of a home supply of vegetables. A few large farms also produce corn, potatoes, asparagus of good quality, and small yields of grass, rye, and wheat.

The sandy, porous character of the Norfolk coarse sandy loam disqualifies it for the production of grass, grain, or the late truck crops, like potatoes, cabbage, onions, etc., under ordinary conditions of farming. It is well adapted to the production of berries, and the fruit produced on this type is excellent in quality. It is not a soil which can be relied upon in a dry season.

The Norfolk coarse sandy loam can be made a valuable fruit and vegetable soil by a small amount of irrigation during the driest portion of each year. Under a greater part of its area the water table is reached at a depth of from 35 to 60 feet. A series of wells which could be pumped by a centrifugal pump would furnish an adequate water supply for small farms of 15 to 30 acres. This treatment could be employed to advantage on all areas south of the older moraine and on many of the intermorainal areas of Norfolk coarse sandy loam. Owing to the porous nature of the soil and the underlying sand beds, water once used for irrigation purposes would rapidly seep downward to the water table and could be reused at no great distance; that is, the irrigation use of water would not seriously affect the supply of well water nor render it unfit for domestic uses.

An experimental plot under irrigation should be tested to ascertain the full value of the system on the Norfolk coarse sandy loam. It is to be understood that irrigation would not be necessary every year nor throughout even the driest season. Probably a water supply equal to 1 foot of rainfall over each acre farmed would amply secure truck crops against drought. Potatoes, cabbage, and all grass or grain crops would require double that amount in addition to the normal rainfall.

Large tracts of Norfolk coarse sandy loam can be secured at a price of $15 to $30 per acre, and even areas within 2 or 3 miles of the railroad can be purchased for $30 to $50 per acre.

The following table shows the texture of the fine earth of this type:

Mechanical analyses of Norfolk coarse sandy loam.

No	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
9008	½ mile S. of Terryville.	Yellow sandy loam, 0 to 36 inches.	0.19	3.50	17.10	15.90	14.70	12.86	25.94	9.40
9006	½ mile SE. of Deerpark.	Coarse yellow sandy loam, 0 to 6 inches.	2.27	7.40	25.84	18.04	13.76	6.96	18.50	9.50
9004	2½ miles NW. of Lindenhurst.	Coarse brown sandy loam, 0 to 8 inches.	3.34	11.48	33.92	18.24	8.62	4.14	13.50	9.96
9007	Subsoil of 9006....	Coarse yellow sandy loam, 6 to 36 inches.	.82	9.98	30.64	18.20	11.62	5.06	16.02	8.10
9005	Subsoil of 9004....	Sandy loam and gravel, 8 to 36 inches.	.78	10.40	35.04	19.94	10.10	4.72	10.68	9.00

SASSAFRAS GRAVELLY LOAM.

The surface soil of the Sassafras gravelly loam to a depth of 8 inches consists of a yellow or reddish-yellow loam, containing from a trace to 20 per cent of small rounded gravel. The subsoil to a depth of about 2 feet is a heavier lemon-yellow or reddish-yellow silt loam, which contains a larger percentage of gravel than the soil. The entire soil mass is underlain by a definite continuous bed of rather coarse gravel. Near the front of the moraine small bowlders occur in both soil and subsoil, while the underlying gravel is coarser, amounting in some instances to a stony band. In almost all localities the Sassafras gravelly loam overlies beds of coarse, cross-bedded sand. Along the moraine, however, this soil type normally overlaps the glacial material for a short distance. Both soil and subsoil contain a greater proportion of silt and clay near the moraine and become more sandy southward as the type slowly grades into the Norfolk coarse sandy loam or the Norfolk sand.

The Sassafras gravelly loam is extensively developed on all parts of Long Island south of the northern moraine. It is divided into two belts by the southern or older moraine, around whose flanks it laps. The interior belt is usually more loamy, less gravelly, and a stronger soil than the southern belt. It also lies higher above the water table.

The surface of the Sassafras gravelly loam in any one locality is nearly level, and interrupted only by old, dry stream channels, which form either a more gravelly phase of the type or narrow stringers of the Hempstead gravelly loam or the Norfolk coarse sandy loam. The Sassafras gravelly loam attains an elevation of 240 feet near Greenlawn. It slopes rather uniformly at a rate of about 10 feet per mile from the moraine front to the southern shore, and its material passes below water level as the subsoil of the Galveston sandy loam. The chief drainage of the Sassafras gravelly loam is by downward seepage into the underlying beds of sand and gravel and thence by percolation seaward at a depth of from 15 to 50 feet below the surface.

The relations of this soil body to both moraines, its position as the last of a series of stratified deposits, the constant association of glacial materials of all sizes, and the universal underlying gravel bed indicate the origin of this type as an outwash material laid down during the latest stages of the glaciation of the island. The uniform and thorough mixing of gravel with fine silt and clay in this type is a phenomenon difficult to explain, except as it may have been brought about by combined wave and stream action. The same soil, as described in Maryland and New Jersey, is a shallow-water sediment of late Pleistocene age, closely associated with glaciation. The same origin is probable on Long Island.

As on all other soil types of the area, the distance from market is the chief factor governing the character of the crops grown on the Sassafras gravelly loam. In Kings, Queens, and western Nassau counties the market-garden crops are chiefly grown. The areas devoted to corn, cabbage, tomatoes, and potatoes are somewhat larger than on the other soils of western Long Island. Farther east in Suffolk County the Sassafras gravelly loam becomes the chief soil type upon which potatoes are grown, while in the vicinity of Riverhead and Greenport, outside of the area mapped, cauliflower is one of its most important crops. In spite of its slight depth and rather gravelly character, the Sassafras gravelly loam is one of the most important soils on Long Island. It is uniformly level, well drained, and easily tilled. The compact character of the fine earth makes it fairly retentive of moisture, while a constant small percentage of medium sand renders it well aerated, warm, and friable. It is too shallow to maintain sufficient moisture for the production of large grain crops or to allow of the formation of extensive root systems for grains and other crops

requiring a long growing season. But it is a good soil for market-garden crops, except in seasons of extreme drought.

Many square miles of the Sassafras gravelly loam are still grown up to pitch pine, scrub oak, and huckleberry bushes. Small areas are found throughout the scrub-oak country predominated by Norfolk coarse sandy loam. Some of these have been cleared, but many still await development. As a large part of this type in Suffolk County can still be purchased for from $15 to $50 an acre, it offers a good opportunity for the further extension of market gardening on Long Island. Areas within driving distance of the city markets are quite fully occupied, but the culture of potatoes, sugar corn, cabbages, onions, and cauliflower, as carried on east of Riverhead, could be successfully undertaken at many points near the railroads in western Suffolk County.

The following mechanical analyses show the texture of the fine earth of the Sassafras gravelly loam:

Mechanical analyses of Sassafras gravelly loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8995	3 miles E. of Hempstead.	Yellow gravelly loam, 0 to 12 inches.	1.92	6.30	18.30	13.02	8.62	6.70	29.30	17.30
8991	1 mile SE. of Queens.	Yellow gravelly loam, 0 to 10 inches.	1.81	5.30	16.10	11.50	10.70	9.38	29.30	17.72
8993	1½ miles SW. of Wardencliffe.	Brown silty loam, 0 to 10 inches.	2.77	1.12	4.22	2.16	2.62	3.46	55.50	30.80
8996	Subsoil of 8995....	Yellow gravelly loam, 12 to 30 inches.	1.66	5.90	19.86	13.94	8.82	6.10	29.10	16.50
899[illegible]	Subsoil of 8993....	Heavy red silty loam, 10 to 36 inches.	.82	3.30	12.92	9.72	10.24	11.82	33.40	18.30
8992	Subsoil of 8991....	Yellow gravelly loam, 10 to 30 inches.	.65	3.80	11.22	7.40	8.62	11.90	36.66	20.60

NORFOLK SAND.

The surface soil of the Norfolk sand, in its cultivated areas, is a medium-grained brown sand, which, on Long Island, frequently contains a small percentage of fine quartz gravel. It is underlain by a yellow or orange medium sand, also slightly gravelly to a depth of 36 inches or more. Both soil and subsoil are locally somewhat loamy. In forested areas the surface soil is frequently gray in color, as the organic matter, giving the brown shades in cultivated fields, has rotted,

and this has furnished organic acids which have dissolved the iron salts, normally giving the yellow and orange colors to all soils.

This soil type is extensively developed along the south shore of Long Island from Jamaica to Lynbrook and again from Amityville to Patchogue. It occurs in an irregular belt covering the ridges between stream channels and extending back from one-fourth of a mile to 3 miles from tide water. In these localities the Norfolk sand is somewhat more loamy than the normal, and the depth to the water table is only from 6 to 15 feet. The soil and subsoil are both somewhat gravelly. The Norfolk sand found near Port Washington and Bayville, on the north shore, is the nearest true to the type, as developed along the Atlantic coast, of any of the Long Island areas. A rather coarse phase of Norfolk sand is found in the interior of the island around Smithtown, again around Selden, and from Patchogue northwestward in a broad belt to Holbrook. A somewhat finer-grained grade of Norfolk sand occurs in the valleys around Hauppauge and below the 100-foot contour line between Lakegrove and Selden. All of these sand areas grade into one another where they are in contact, so that no subdivision, with boundaries, can be drawn, and all have nearly the same agricultural values. The differences in texture are so slight that depth to water table is a factor exerting a greater influence on crop adaptation and yield.

With the exception of the sandy valley walls northwest of Hauppauge the surface of the Norfolk sand is nearly level or only gently undulating. The level of south shore areas is only interrupted by the shallow stream valleys separating them; otherwise the plain slopes from an elevation of 25 to 35 feet down to sea level, usually in a distance of 2 or 3 miles. The interior areas are rather more rolling, owing to a small movement of the soil by the wind, which has produced incipient sand dunes. The north shore areas are usually flat-topped terraces, and the only slopes found in the type are along the outcrops formed around the terraces. Owing to the large size of the pore spaces in the main bodies of the Norfolk sand the greater part of the rainfall is conducted downward by gravitational flow, only a small water content is maintained by capillarity, and as a result few streams or marsh areas are found. The drainage is so perfect over the greater portion of this type that it does not maintain sufficient moisture for grass and grain crops. This feature fits it, however, for the production of certain special crops.

The greater part of the Norfolk sand on Long Island has been deposited as a coarse water-borne sediment. South of the moraine this was accomplished as outwash from both glacial advances, while along the north shore the areas were formed as delta deposits in locally ponded glacial waters during the final retreat of the ice. Near Selden a part of the outwash sand has been reworked since deposition

by wind action. This is also true of some of the material along the south shore, where the process may be seen in progress over cultivated fields on almost any windy day.

The Norfolk sand consists chiefly of medium to fine grades of pure quartz sand, usually stained to an orange or yellow color by a coating of hydrated salts of iron. In the forest areas this coloring matter has been leached from the surface 6 inches by organic acids derived from the decay of leaf mold. This leaves a silvery gray sand, almost totally devoid of organic matter, iron salts, and of everything but pure silica. In the cultivated areas the ordinary processes of cultivation have incorporated sufficient organic matter to give the surface 10 inches a deep brown coloring. A lack of this color denotes a deficiency in humus, and should be corrected by the application of organic manures and the plowing under of green crops, like rye, clover, or cowpeas.

The Norfolk sand in all of its occurrences along the Atlantic coast is a typical early truck soil, the date at which crops can be matured depending on the latitude of the area, its altitude, and its proximity to tide water. It is almost always the earliest soil in each region where it occurs. Hence it is sought after for the production of such crops as derive a high value from being forced to an early maturity. It owes its properties to the capability of a well-ventilated soil to become warmed to a sufficient degree to germinate seed early in the season, to its low moisture-holding properties, which cause an early fruitage rather than a strong development of the plant, and, secondarily, to the fact that it usually occurs in such a position as to secure whatever advantage of climate is found in low altitude and proximity to large bodies of water.

On Long Island, particularly in the market-garden region west of Lynbrook, the Norfolk sand produces early peas, early potatoes, and early sweet corn, besides rhubarb, carrots, parsnips, beets, radishes, string beans, early tomatoes, and even cabbage, onions, and lettuce. The area mapped near Bayville, on the north shore, is largely devoted to the production of an excellent quality of asparagus. In the vicinity of Selden some sweet potatoes and watermelons are grown. Berries and small garden vegetables are also produced in that vicinity, in addition to corn and potatoes. The area near Port Washington and the larger part of the belt of the Norfolk sand along the south shore from Patchogue to Sayville are held as country estates or occupied by village sites and club grounds, so that their agricultural value is of little importance to the owners. Along the south shore the slight depth to water table, only 8 to 15 feet, detracts somewhat from the value of this soil for trucking, but adds to its ability to produce grains, grasses, and the water-loving varieties of shade trees and ornamental shrubs.

The large uncultivated interior areas of Norfolk sand found northwest of Patchogue, around Selden and eastward on Long Island, are

rather more droughty than the average of the type. In their present state they are better suited to the production of melons and sweet potatoes than to any other crops. They possess a considerable value for these crops, and as large tracts within 3 or 4 miles of the railroads can be purchased at from $7 to $20 an acre, they should be utilized for the truck industry as distinguished from market gardening. Experiments with the irrigation of strawberries near the south shore have yielded a profit of over $300 an acre. The successful utilization of the interior areas of Norfolk sand requires some capital and a considerable knowledge of growing special crops, particularly sweet potatoes and melons.

The usual truck crops can be grown to advantage on all other areas of the Norfolk sand mapped. As mentioned, this soil is especially well adapted to asparagus, to early potatoes, peas, early tomatoes, early cucumbers, and in general to the light trucking crops.

The following mechanical analyses show the sandy nature of this soil:

Mechanical analyses of Norfolk sand.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8982	2 miles NW. of Patchogue.	Medium sand, 0 to 36 inches.	0.56	4.80	35.84	25.02	16.82	3.42	9.82	4.20
8981	1 mile SW. of Bayville.	Yellow medium sand, 0 to 36 inches.	.50	1.50	9.74	20.76	49.94	8.76	5.10	4.22
8979	2 miles E. of Babylon.	Brown loamy sand, 0 to 16 inches.	1.14	5.50	30.50	17.12	9.12	5.66	20.40	11.80
8980	Subsoil of 8979.....	Yellow loamy sand, 16 to 36 inches.	.11	9.44	33.18	20.90	10.08	3.70	15.40	7.30

MEADOW.

The term Meadow is used in this report to indicate any low-lying, generally flat area normally too wet for the cultivation of ordinary field crops. The salt marshes and salt meadows are excluded, being mapped as the Galveston clay and the Galveston sandy loam.

The meadow areas of Long Island fall into two main classes—the wet areas occupying hollows in the moraine belt (kettle holes) and the broad, shallow, irregular depressions in the plateau region which are somewhat different in character from the long, narrow belts found along stream channels. In both cases the meadow condition is due to obstructed drainage. In the case of the stream channels this obstruc-

tion is consequent on a low gradient in the channel, followed by rank growth of water-loving trees and plants whose roots, stems, and foliage offer an additional resistance to the current. This condition can be removed by clearing out the vegetation and by cutting a simple open ditch, or, better, by placing a tile drain of sufficient size to conduct the ordinary flow of water along the line of the channel, but beneath the surface. In the case of the larger streams a little attention to clearing out undergrowth will enable them to maintain their own channels. Smaller streams can be conducted through open ditches, while stagnant pools should be tapped by tile drainage. An impeded drainage of slightly different character occurs along the north shore, causing springy areas at or near the bases of steep slopes, especially where clay layers are present. Such areas should be relieved by tiling laid parallel to the spring line for the collection of the seepage water, connected with a large outflow system, into which several branches may lead.

The kettle-hole and broad meadow areas of the glacial area are usually surrounded completely by a rim of high-lying land through which a cutting is sometimes impracticable on account of the length or depth to which it must be carried. As the majority of these areas are due to a local layer or bowl of nearly impervious loam or clay, and as this layer is frequently thin and nearly always rests upon sands or sandy loams, the cesspool method of drainage can be used to advantage, especially on the smaller meadows. A well proportioned in depth to the area to be drained should be sunk to a layer of really sandy soil. The best practice would then be to tile drain into a bricked or stoned cesspool, but when an expedient must be employed, the cesspool may be filled with medium-sized field stone nearly to the plow line and then covered with earth. Such a makeshift is apt to fill with fine earth and to give merely temporary relief.

From the standpoints of utility, health, and beauty the meadow areas should be drained. The larger meadow areas possess soils of nearly the same character as the adjoining areas, though usually more loamy and, when properly drained, more drought resistant and productive. Nearly all of the areas mapped on Long Island are well suited to the production of celery, onions, cabbage, and lettuce.

No samples were taken for analyses, as meadow is a soil condition rather than a definite soil body.

RECLAMATION OF FRESH AND TIDE-WATER SWAMPS.

The marsh areas occurring upon Long Island are of three different kinds. Two of these classes are fresh-water marshes; the third constitutes the tide-water marsh along the shores. In the upland region of the island there occur scattered through the glacial area many small ponds and kettle holes, some of which, during the wetter por-

tion of the year, are veritable little lakes. The majority of them, however, are rapidly reduced to the condition of bogs and mudholes with the advance of summer. The greater part of them have no natural outlet, but lose their water by seepage and evaporation. A few are used as natural cisterns for watering stock. The majority are merely accumulating beds of muck, furnishing breeding grounds for mosquitoes. Some of the worst of them occur within the city limits of Greater New York, near Bayside, Flushing, Corona, and Astoria. The larger ones are represented on the map as meadow; but many of them, constituting separate areas of only 2 or 3 acres, are too small to map. In the majority of cases a single deep cut, with the laying of a few rods of large-size tile, would furnish adequate outlets with which the areas could readily be drained at an expense of about $15 per acre for ditching and tile. Aside from the desirability of this treatment on the basis of comfort and sanitation, the reclaimed areas would possess values of $200 per acre and upward for the production of agricultural crops. The moist, mucky areas thus reclaimed are admirably adapted to the production of celery, onions, and cabbages, and similar lands located elsewhere in the State have been thus reclaimed merely for agricultural purposes, where the final value of the land has amounted to only one-fourth or one-fifth as much as the increase in value which would follow the reclamation of these bogs on Long Island.

The second class of fresh-water marshes on Long Island consists of long, narrow stream beds, particularly frequent on the south shore. These channels are not the beds of existing streams, but are merely the survivals of a more active drainage which occupied them at the close of the Glacial epoch. The upper part of the channels is at present dry in all ordinary seasons. In the central portion of the drainage the water table approaches near enough to the surface so that a constant trickle of water, not sufficient to form a definite stream, occurs during the winter portion of the year. Farther down this seepage accumulates to form true streams, whose margins are frequently marshy and whose channels are choked and obstructed by dense growths of herbage and trees. In the majority of cases almost complete reclamation would follow the removal of obstructing vegetation and the digging of a few open ditches, but the land so reclaimed would be of little agricultural value.

Many thousand acres along both shores of Long Island consist of shallow tidal flats, exposed to the air at low tide and just awash with salt water at high tide. Over these tide flats, which consist in part of sand and gravel and in part of deep, sticky, drab mud, colonies of eelgrass have spread, or are spreading, a dense growth of vegetation. This eelgrass retards the natural drainage of the flats, entangles more and more mud, silt, and sand, and slowly builds the marsh to high-

tide level. At the same time the eelgrass spreads seaward, unless its encroachment is stopped by the destructive action of waves along its seaward margin. Along the south shore Jamaica Bay, Hempstead Bay, and Great South Bay are protected by barrier sand bars, and the shallower portions of the inlying bays are occupied by islands and shore fringes of eelgrass salt marsh. Borings taken during the progress of the survey revealed two distinct soil types over these marsh areas. In the shallower portions, and especially where the front land was sandy, as well as on the lee side of the barrier beaches, about a foot or 18 inches of eelgrass turf mingled with mud forms the surface soil of the salt marsh. It is underlain by sandy, gravelly loam of unknown depth. This material was mapped as Galveston sandy loam, which is described elsewhere in this report. Throughout all the deeper portions of the embayments the eelgrass turf and mud attains a thickness of 2 to 4 feet, and is underlain by the plastic drab and mottled mud to a farther depth of 6 to 10 feet. This usually rests upon yellow or white sand and gravel. The eelgrass areas are intercepted by narrow, tortuous tidal channels, in which the maximum distance between high and low tide amounts to from 3 to 6 feet. Small water holes or ponds are also formed throughout the tidal flats, and a few sandy or gravelly islands rise a few feet above their upper limit. Such a tide marsh area is extremely difficult to reclaim. The bordering areas along the shore can be diked and drained to good advantage, but the similar treatment of the islands and hassocks farther out in the bays would constitute an extremely expensive engineering proposition, and the profit to be derived from such treatment could be large only in the immediate vicinity of the city.

The north shore tide-water marshes consist almost entirely of triangular-shaped areas of the Galveston clay, with their bases presented seaward and their apexes penetrating far inland. In almost all cases the surface foot or two of eelgrass turf is underlain by 10 or 20 feet of the Galveston clay. Through nearly every one of these marshes a single pronounced tide-water channel reaches back toward the apex, where it receives the drainage of large or small fresh-water streams. The two landward sides of the triangle are usually bounded by rather high, sandy cliffs, through which many springs descend to the water level, often forming a fringe of fresh-water marsh vegetation along the sides of the eelgrass. In several instances railroad and highway embankments cross the marshes near their seaward base, and the only connection at present existing between the salt marsh on the landward side and tide water on the other side is under narrow culverts and swing bridges. In almost all instances, if it were not for the adverse interests of a small amount of navigation the present points of ingress of the tide could be closed by a few hours' work. With a tidal range

of 5 to 7 feet, which exists along the Sound, shore diking, the construction of flood gates, and a few floodings with fresh water would rapidly reclaim by far the larger part of all the north-shore marshes. If the adverse interests of navigation can not be voided, the present tortuous tide-water channels should be dredged straight by scow and steam shovel, and the dredgings dumped on either side of the canal, thus diking off the marsh into two portions. All of the land so reclaimed could in the course of two or three years be washed clear enough of salt to permit the growth of asparagus, onions, and beets, while a little longer time would permit the growth of all general farm products. The productiveness of such reclaimed land is not a question for doubt. The experience of Holland, England, and the United States has shown that such lands, properly reclaimed and handled, are among the most valuable known to agriculture.

Gloucester and Salem counties, N. J., have reclaimed upward of 20,000 acres of similar marsh land by the construction of banks and ditches. The fresh water gathered by the diked areas flows into broad, open ditches, and is collected in a large, open ditch located a little way inside of the protecting dike. Thence it is drained out by automatic flood gates at low tide. In one instance a large main ditch or canal is used for steam navigation near Salem, N. J. The New Jersey marshes were reclaimed merely that tame grass might be grown for hay and pasturage in place of the salt grass which had preceded it. The added value of the pasturage and hay cut has alone warranted the construction of these works in a region where the land values range from $40 to $100 an acre. In some few instances corn, cabbage, tomatoes, onions, celery, and other crops have been grown in small areas, producing large yields; but the expense of reclamation has been justified and has been borne by the increase in grass values alone. In one case, owing to disputes between the boards concerned in the reclamation of an area, the works have been allowed to go out, but their repair was a subject of discussion during the time that the Salem area was being surveyed.

For further information in regard to the seacoast marsh problem, reference is made to the U. S. Geological Survey Sixth Annual Report, "Seacoast Marshes of the United States," by N. S. Shaler; Special Report No. 7 of the U. S. Department of Agriculture, "Tidal Marshes of the United States," by D. M. Nesbit; various reports of the New Jersey Geological Survey; Tenth Annual Report U. S. Geological Survey, "Fresh Water Morasses of the United States," by N. S. Shaler; "Engineering for Land Drainage," by C. G. Elliott; and Circular No. 8, Bureau of Soils, U. S. Department of Agriculture, "Reclamation of Salt Marsh Lands," by Thomas H. Means, which circular was written with special reference to Long Island conditions.

AGRICULTURAL CONDITIONS.

With certain restrictions, the character and condition of agriculture on Long Island varies inversely with the distance of a given community from the ferry points leading to New York City. The chief factor producing a departure from this rule is found in the proximity of the agricultural community either to the ocean or the Sound. This second factor is an older one which survives against the encroachment of the first. Thus, in the early days, proximity to water transportation largely influenced the character and prosperity of the agricultural community. Within the last thirty years, however, the extensive construction of fine macadam roads leading out from Brooklyn through Kings, Queens, and Nassau counties has counterbalanced the former advantage of water transportation. Similarly, the rapid increase in population within the bounds of the Greater New York has led to an intensification of farming methods generally, greatly emphasizing the differences in agricultural method which had begun to exist even before that period. The influence of natural soil fertility upon crop production, though still shown to some degree, is rapidly decreasing in effect through the employment of large amounts of commercial fertilizer and stable manure, and through increasing intensity of cultivation.

In Kings and Queens counties, which are included in the Greater New York, the average size of farms at present amounts to 18 acres and 21.6 acres, respectively, while in Nassau and Suffolk the average size is 53.3 acres and 84.5 acres, respectively. Similarly, in Kings and Queens counties the percentage of improved land to the total acreage held in farms is, respectively, 92 per cent and 85 per cent, while in Nassau it is 78 per cent, and in Suffolk only 47 per cent. Another interesting fact is found in the number of square feet of land under glass in the several counties, which is as follows: Queens, 2,642,930; Kings, 948,000; Nassau, 420,020, and Suffolk, 315,000 square feet.

The above figures show the concentration of the production of the various classes of flowers and forcing-house vegetables within the limits of the Greater New York. This extremely intensive form of plant production is dependent neither upon climatic nor soil conditions, since both climate and soil are artificially produced.

The farming in the three western counties of Long Island is extremely intensified, even when the production of flowers and nursery stock is excluded. It consists of the production of market-garden crops under intensive conditions of farming, of the production of truck crops at a greater distance from the market, and of the production of special crops, like cucumbers, for pickling, and asparagus, cauliflower, cabbage, and potatoes for shipment by rail.

Within the city limits unoccupied lots and tracts held for subdivision are rented in small plots for market-gardening and trucking purposes.

While farmers of American birth still engage in this work to a considerable extent, it is largely carried on by Italians, Poles, and Germans. Even a few Chinese are engaged in the production of oriental vegetables in Queens County. With the Italians and Poles, the entire family work in the market garden, and very little labor is hired. On the other market-garden farms, managers, gardeners, and day laborers are extensively employed, so that in Kings and Queens counties the cost of labor per acre of improved land amounts to $42.50 and $34.30, respectively. On these farms the expenditure for fertilizer is also highest, amounting to $14.30 per acre of improved land in Kings County, and $14.80 per acre in Queens County. The value of the land per acre in Kings County is $1,230; in Queens, $461; in Nassau, $124, and in Suffolk, $49. The value of farm produce not fed to live stock per acre of improved land is, respectively, $185.25 in Kings, $138.05 in Queens, $38.30 in Nassau, and $22.45 in Suffolk County.

The market-garden farms within the city limits are usually of small size and are subdivided into plots of one-half or one-fourth of an acre, or even less. It is the aim of the market gardener to keep some crop growing and ready for market during all months of the year, with the exception of a few weeks in winter, when the marketing of stored root crops or of fruit takes his attention. In the early spring the kale, spinach, and rhubarb are bunched and taken to market. Early peas, sweet corn, radishes, and potatoes are planted, and the onion beds laid out. As radishes, lettuce, and onions are bunched out for market their place is taken by later crops of peas, potatoes, and corn. The early peas, potatoes, and corn are frequently followed by tomatoes, cabbage, Savoy cabbage, kale, and spinach for late harvest. In the production of all these crops large amounts of stable manure are used. It is purchased in the city and transported to the farm either by wagon, by rail, or by scow, depending on the location of the farm. Stable manure delivered on the siding at the more remote points costs from $1.10 to $1.60 per ton. Commercial fertilizers are used in addition, normally at the rate of about 1,000 pounds per acre, although 2,000 and 2,500 pounds per acre are not infrequent applications. Several farmers in the area surveyed stated that their expenditures for labor and fertilizer in the preparation of their land range from $35 to $60 per acre, depending on the character of the crop and the intensity of the cultivation.

The farm products within a radius of from 30 to 35 miles of the ferries are transported to market in large, specially constructed two-horse market wagons. On certain of the routes an additional two-horse tow, hitched to the front wheels of an ordinary farm wagon, helps the heavily loaded market wagon over the steep grades along the northern shore of the island. The wagons are frequently loaded during the afternoon and make the journey at night, returning the next

morning. The larger farms, more remote from the city, consequently employ two or more wagons and teams in their market service. The products are sold in the city to wholesale or retail grocery houses and in the open market. Very little peddling is done by the producers of market-garden crops.

A notable feature of Long Island conditions is the selection of certain desirable localities for the nonagricultural country seats of wealthy New York business men. The region along the north shore, on account of its elevation and proximity to the many embayments leading out from Long Island Sound, has long been a favorite residence section. Within recent years the most desirable locations have been purchased at values of from $500 to $6,000 per acre, and the new owners have employed landscape architects, foresters, and gardeners in the improvement and management of their estates. More recently the high morainal ridges have been selected for country seats of large size, and their care and improvement have involved the expenditure of large sums of money for labor, fertilizers, shrubbery, and general improvements. Almost the entire southern shore is occupied by a continuous belt of summer residences and summer-resort towns. In almost any other region the effect of these conditions would result in marked changes in agriculture and in a stimulation of agriculture through the increase in market facilities. On Long Island the immense influence of the great city market at its western end minimizes these local conditions, and they sink to comparative insignificance.

Aside from the market-garden and truck interests of Long Island, which are largely confined to the western counties, the production of white potatoes is the chief industry. The most important potato-raising region lies outside the limits of the present survey, on the extreme eastern end of the island. Many potatoes, however, are produced in Nassau County and in western Suffolk County. On account of the extensive use of fertilizers variations in yield are dependent more upon climatic influences and upon the ravages of disease than upon variations in soil types. In general, a fairly good season will show a yield of about 200 bushels per acre. On the smaller farms yields of 230 to 250 bushels per acre are frequently reported. The influence of the Long Island yield upon market prices is most strongly felt during the month of September. As a result, the production of early potatoes is more to be desired than a larger yield and a later crop. The earliest potatoes are produced upon the more sandy types of soil, especially upon the Norfolk sand area southeast of Hempstead. Larger crops of later potatoes come from the Sassafras gravelly loam and the Hempstead loam. The Sassafras gravelly loam may perhaps be considered the chief potato soil of Long Island.

The production of cucumbers for pickling houses constitutes an important phase of agriculture in the region around Hicksville and

Farmingdale. The Alton stony loam and the Sassafras gravelly loam comprise the larger part of the acreage. The cucumbers are sold by count to the packing factories, and in normal years yield a good profit. Some tomatoes are also raised in the same general region. The production of asparagus is largely localized around Oyster Bay, where a small area of the Norfolk sand is chiefly devoted to this crop. The Alton stony loam is also adapted to its production.

The fruit interests of Long Island are not of great magnitude. The morainal hills through the center of the island bear many old apple orchards, which are producing a smaller and smaller yield every year. The chief peach district lies in the Halfway Hollow Hills, where several fine orchards exist. A few orchards have recently been started on the plains near Hicksville and Hempstead. The Sassafras gravelly loam, which occupies such large areas on Long Island, has been found in Maryland and New Jersey to offer soil conditions well adapted to the production of peaches, plums, and cherries, and only climatic conditions of a pronouncedly unfavorable character could prevent the profitable culture of these crops on the type as it occurs on Long Island. A few new orchards of pears, chiefly Kieffers, have been planted in the vicinity of Huntington. They have grown well and produced abundant crops, with a good margin of profit. Pear culture on this type should meet with pronounced success. It is also well adapted to the production of grapes.

The following adaptation of crops to soils is proposed as a result of the observations made during the progress of the survey:

The Miami stony loam is particularly adapted to grass and grain crops, to late truck crops, including onions, cabbage, and cauliflower, and to apples and pears among the fruits. It is not infrequently desirable to underdrain this type by the use of tile.

The Alton stony loam is suited to the production of early potatoes, sugar corn, truck crops, peaches, cherries, and plums; and in its more loamy phases to cucumbers, tomatoes, and potatoes.

The Plainwell stony loam in most cases is not suited to agricultural purposes. It should be reforested to chestnut, locust, and oak. In some localities, where it is not too dry, it might be devoted to peach orchards and early truck crops.

The Hempstead loam of the Hempstead plain is one of the best general farming soils of the island. It constituted the only large prairie region east of the Allegheny Mountains. It is well adapted to the production of grass and grain, to the cultivation of the later truck crops and potatoes, and to the later market-garden produce, such as cabbage, sugar corn, onions, root crops, etc.

The Hempstead gravelly loam is adapted to about the same crops as the Hempstead loam, though requiring heavier fertilization, and even then producing smaller crops.

The Sassafras gravelly loam will produce a wide range of farm crops, with only average yields. It is especially adapted to the production of potatoes, tomatoes, and the small varieties of sugar corn. It also gives fair yields of cucumbers, cabbage, cauliflower, and onions. It is well adapted to the production of peaches, plums, cherries, blackberries, raspberries, currants, and strawberries. Its chief requirement is the annual incorporation of large amounts of organic matter. Green crops should be plowed under and stable manure liberally applied.

The Norfolk sand is the chief early trucking soil of the entire Atlantic coast region. On Long Island it consists of three closely related phases. The most prominent of these is the loose, porous, yellow sand of the southern plain portion of the island, which is so extensively covered with scrub oak and pitch pine. Its present lack of agricultural value is chiefly due to the considerable depth at which the water table lies. Where the water table approaches nearer to the surface, as along the southern shore, the soil is slightly more loamy, and its high agricultural value as a trucking soil is clearly recognized. Upon this second phase very early crops of peas, corn, potatoes, asparagus, beets, carrots, parsnips, and rhubarb are produced. A few small fields of alfalfa were seen in excellent condition, and general farm crops do fairly well. The third phase, found in the vicinity of Hauppauge, is slightly finer in texture, and a little more retentive of moisture than either of the others. It constitutes a fairly early truck soil, and would be well adapted to the production of sweet potatoes and melons.

The Sassafras sandy loam occurs only in small areas in Kings County, and is well adapted to market gardening and trucking.

The Norfolk coarse sandy loam, under present conditions, is almost entirely overgrown by scrub oak and pitch pine. Without irrigation it possesses low agricultural value, though, like the Norfolk sand, it yields fair crops where the water table is near the surface. A considerable proportion of this type could be irrigated from wells at a small expense, and would then be suited to the production of small fruits and truck crops. Its barrenness is to a great degree due to a lack of sufficient moisture.

The Norfolk coarse sand, Galveston sand, and Norfolk gravel are not suited to agricultural purposes, and should be reforested and not included in farm lands.

Meadow, Galveston clay, and Galveston sandy loam are types which can only be used for agricultural purposes after extensive diking and drainage operations. These are considered in a separate chapter.

The most striking features of Long Island agriculture are the influence of an immense local market, giving rise to intensive cultivation on the western end of the island, the survival of older methods of

agriculture at more remote points, the occupation of particularly desirable localities for country residence and summer resort purposes, and the almost utter abandonment of the most sandy types of soil on account of typically eastern desert conditions, even though the rainfall amounts to more than 40 inches per year. This latter phase is the more unaccountable, as small local irrigation plants have shown the capabilities of soils when sufficient water is furnished. Moreover, almost the entire area is underlain by water-bearing strata at a depth of from 20 to 50 feet.

In some respects Long Island displays a concentration and progress in agriculture which might well be imitated in other sections, but a large part of the area surveyed is in the same condition as the abandoned land of the Connecticut Valley and other eastern regions.

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U.S. DEPT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF

SOIL MAP

NEW YORK
BABYLON SHEET

Soils surveyed by
Jay A. Bonsteel and party
1903.

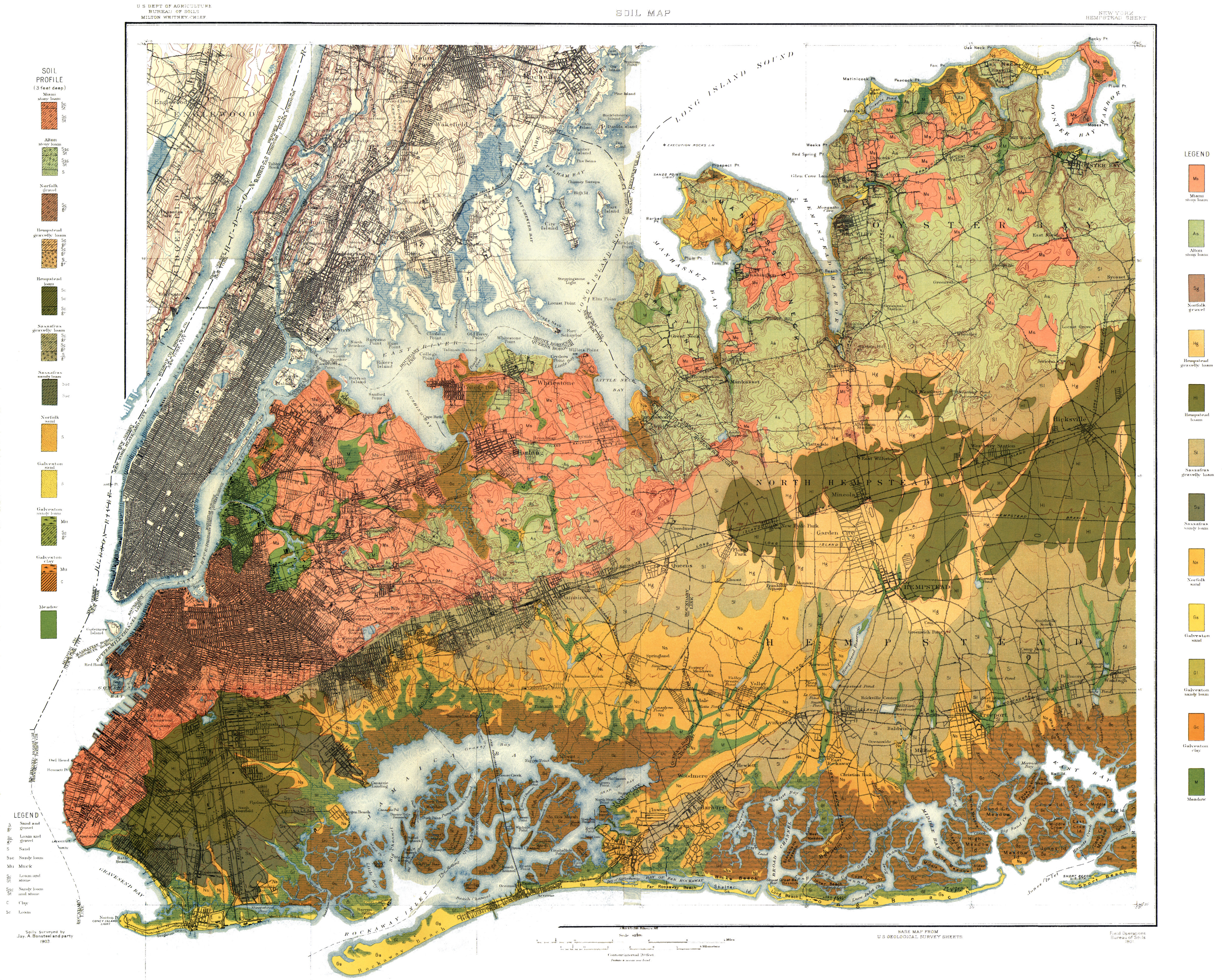
A. Hoen & Co. Lith. Baltimore, Md.

Scale $\frac{1}{62500}$

Contour interval 20 feet.
Datum is mean sea level.

BASE MAP FROM
U.S. GEOLOGICAL SURVEY SHEET

Field Operations
Bureau of Soils
1903


U S DEPT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
SOIL MAP
NEW YORK
HEMPSTEAD SHEET
SOIL PROFILE
(3 feet deep)
Miami stony loam
Alton stony loam
Norfolk gravel
Hempstead gravelly loam
Hempstead loam
Sassafras gravelly loam
Sassafras sandy loam
Norfolk sand
Galveston sand
Galveston sandy loam
Galveston clay
Meadow
LEGEND
Ms Miami stony loam
As Alton stony loam
Ng Norfolk gravel
Hg Hempstead gravelly loam
Hl Hempstead loam
Sl Sassafras gravelly loam
Ss Sassafras sandy loam
Ns Norfolk sand
Gs Galveston sand
Gl Galveston sandy loam
Gc Galveston clay
M Meadow
LEGEND
S/Gr Sand and gravel
Sc/Gr Loam and gravel
S Sand
Ssc Sandy loam
Mu Muck
Sc/St Loam and stone
Ssc/St Sandy loam and stone
C Clay
Sc Loam
Soils surveyed by
Jay. A. Bonsteel and party
1903
LONG ISLAND SOUND
OYSTER BAY
NORTH HEMPSTEAD
HEMPSTEAD
JAMAICA BAY
GRAVESEND BAY
ROCKAWAY BEACH
Long Beach
Short Beach
Scale 1/62500
Contour interval 20 feet
Datum is mean sea level
BASE MAP FROM
U S GEOLOGICAL SURVEY SHEETS
Field Operations
Bureau of Soils
1903